Selling Functions

A study of environmental and economic effects of selling functions

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Abstract

This report is the result of a research project conducted by ABB, Electrolux and Volvo. The project was carried out by employees from the three companies as part of their engagement at the Competence Centre in Environmental Assessment of Product and Material Systems (CPM).

The aim of the research was to study the environmental and economic effects of selling functions instead of products. A literature search has been carried out and two case studies have been performed. The cases involved each one of the partaking companies. Life cycle assessment, LCA, was used to assess the environmental impact of the functions.

When a supplier sells a function he provides a combination of physical products, consumables and services in order to secure that a buyer can benefit from the function of the physical product without having to own, maintain, repair or dispose of the product. The buyer pays according to the sophistication of the function as long as his need remains, as a running expense. The challenge for the supplier is to optimise the function for the specific application and to reduce the associated cost of labour, consumables, maintenance and repair, as well as the the environmental impact.

Many manufacturing companies, including the manufacturers of cars, white goods and electrical equipment, offer leasing, but only in a limited way and without any advanced reuse of the equipment. One difference between selling functions and operational leasing is that the supplier, by guaranteeing the function, is free to use any new or old products and parts as long as they provide the agreed function.

Selling functions can have a number of environmental benefits. One potential benefit is that it facilitates and creates incentives for reuse of used products and parts to create new functions. Reuse would be easier because of the control the concept would give the supplier regarding maintenance and repair as well as the timing of when a machines is taken back. A more extensive reuse is also important for another reason. The concept is expected to shorten the period of use for each product and reuse will keep the returned products from becoming waste prematurely. The sale a function also provides the supplier with an opportunity to turn possible future take-back obligations into competitive advantages.

Selling functions instead of the physical product in order to improve the corporations' environmental performance is a relatively new concept within environmental literature. To focus on the function instead of a physical product is not, however, a new concept.

Two case studies have been performed to make it possible to evaluate the environmental and economic effects of selling functions. One case focused on the function of a paint box, sold by ABB to Volvo Car Corporation. This case study is a theoretical discussion, as no practical test of the concept was made. The other case dealt with the function of a cleaning machine actually provided by Electrolux Euroclean to the contract cleaning company ISS.

In the case of the paint box, major economic and environmental benefits could be gained from the concept for both ABB and Volvo. A technology improvement reducing the paint loss from 40% to 30% (= 61 SEK/car body) would represent a saving of 10.4 million SEK per year. If the process from decision to implementation for new technology could be speeded up, large gains could be made. Paint consumption, energy use and lead times for new technology could be reduced. Energy and paint consumption gives the largest contributions to the environmental impact according to the 10 weighting methods that were used. However, painting is a core process over which Volvo does not want to give up control. ABB on the other hand is presently not qualified to run the paint shop, as selling the function would require. Instead it was agreed that a closer co-operation in the form of a partnership was more desirable and the concept of selling functions may become interesting to test in the future.

In the Electrolux Euroclean case the concept proved to work in practice. It has met a strong interest from other qualified customers, for economic, quality and environmental reasons. It is, however, hard to quantify the expected environmental and economic savings since the current impact and costs are not known. In a typical case, without the benefits of the concept, the total impact can be expected to be higher and even much higher. There are four different sources that together cause more than 95 % of the environmental impact related to the machine. The sources are; the production and recycling of the material used to make the machine, the production of the electricity used to charge the batteries, the material used for the manufacturing and recycling of the lead batteries, and the material used for maintenance and repair. The secured match between the specific need and the appropriate and guaranteed function, that the sale of a function brings, reduce the impact from all these sources.

In both cases the equipment represents only small portion of the total cost of the functions. The differences in how easy it was to get customer acceptance for the concept reflect the fact that the paint box function is related to a core process and not a supporting process. It is harder to introduce the concept for a process which is a core process.

Selling functions makes it necessary to establish a long-term relationship for co-operation between the supplier and the buyer. Thus it is important to develop ways to share cost savings and the effects of improved quality and overall effectiveness. Competition can, on the other hand, be reduced as the buyer chooses one special supplier to work closer with. Other suppliers might think it is not worth while trying to compete with them. From the buyer's point of view this can make the range of alternatives diminish.

The concept of selling functions has a great potential for reducing the functions environmental impact and increasing the value of what the supplier provides. Several challenges remain and there is a need for more environmental, economic and technical research. The largest challenges, however, seem to be to create a customer understanding of the value of a function and to transform the product focused mind set of the supplier's organisation to a more service and solutions focused way of thinking.

Preface

This report is the result of a research project conducted by ABB, Electrolux and Volvo. The project has been carried out by employees from the three companies as part of the companies' engagement in the Competence Centre in Environmental Assessment of Product and Material Systems (CPM).

In addition to the case studies, a research assistant at Gothenburg Research Institute performed an initial literature study. A postgraduate student of the Stockholm School of Economics later made another, more extensive literature study.

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Introduction

This report discusses the environmental and economic consequences of a shift from selling products to selling functions. It consists of seven parts that account for

- how the project has been executed,
- the background for the project,
- how the concept is discussed in environmental and management literature,
- the conclusions from two separate case studies,
- a general discussion of the concept of selling functions and
- a summary of the conclusions drawn.

The project

The concept of selling functions have a number of potential benefits over the traditional sale of products. However these befits have yet to be proven in most industries. This report is the result of a project that has addressed some fundamental questions. It has also identified several others that remain to be addressed.

When a supplier sells a function he provides a combination of physical products, consumables and services in order to secure that a buyer can benefit from function of the physical product without having to own, maintain, repair or dispose of the product. The buyer pays according to the sophistication of the function as long as his need remains, as a running expense. The difference between selling functions and operational leasing is that the supplier by guaranteeing the function is able to use any new or old products and parts as long as they provide the agreed function.

Goals

- Evaluate the consequences of a transfer from selling products to selling functions regarding environmental impact, economic aspects, and product development.

Method

A literature search has been carried out and two case studies have been performed, involving each one of the partaking companies. Life cycle assessment, LCA, was used to assess the environmental impact.

The cases

For ABB and Volvo a robot cell for painting cars was chosen for the case study. Volvo buys the robot cell from ABB. The idea of choosing this object was to study a case where ABB and Volvo have a producer/client-relationship. This gave us an opportunity to study a selling function process from both a supplier's and a buyer's point of view.

The cleaning machine case was chosen as Electrolux Euroclean had already started to test the sale of the functions of this type of products. In both cases, the buyers are companies and not private persons.

Background

Hypotheses regarding how selling functions could reduce environmental impact
With most present business strategies, where the ownership of a product is legally transferred at the point-of-sale, the price of the product can not increase above a certain level. This price focus governs the material choices to a larger degree than environmental considerations. With retained ownership, and the sale of the function of a product, the freedom of design would increase greatly.

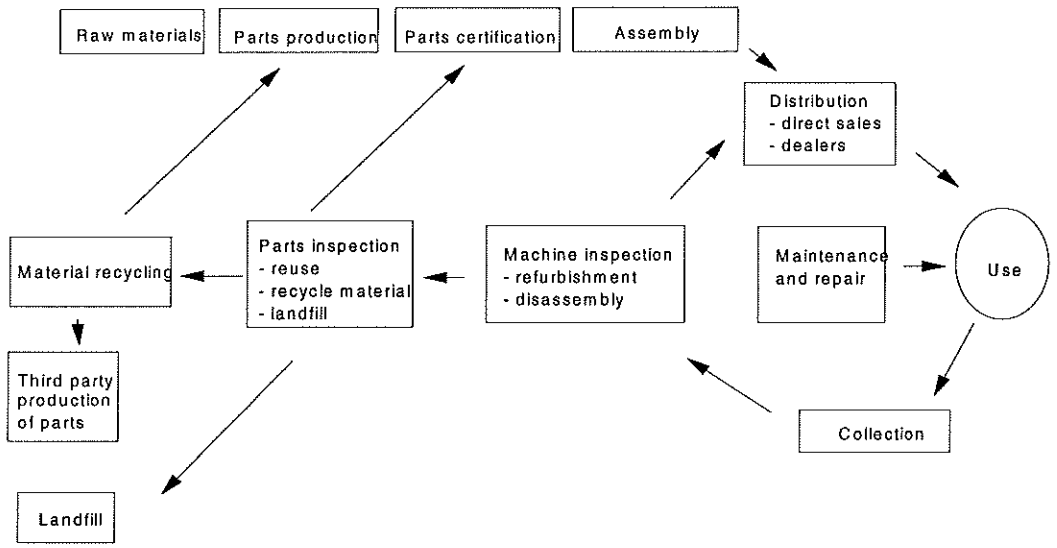
The absence of ownership transfer also facilitates implementation of new more advanced and resource efficient technology, which in turn can reduce the environmental impact. Motors with high efficiency are one example of this. Energy losses can be reduced considerably by material selection, but the demand for high efficiency motors is limited due to the price sensitivity of most customers. Further more expensive materials could be used if they are environmentally beneficial and if the Life Cycle Cost, (Appendix 1), could be kept the same or lower. The sale a function also provide the supplier with an opportunity to turn possible future take-back obligations into competitive advantages.

Selling functions can have a number of other environmental benefits. One potential benefit is that it facilitates and creates incentives for reuse of used products and parts to create new functions. Reuse would be easier because of the control the concept would give the supplier regarding maintenance and repair as well as the timing of when a machines is taken back. A more extensive reuse is also important to keep the expected increase in product turn over from resulting in premature waste. Other environmental advantages could be:

- decreased use of virgin materials in production
- increased life time of each part of a product
- minimised number of times materials pass through the production cycles

The introduction of remanufacturing and reuse schemes allow manufacturers to make use of parts that are still technically possible to use but that are thrown away today.

Figure 1. Illustration of remanufacturing and reuse scheme



An example of selling functions is the way Xerox offers their copiers. Their real product is the guaranteed availability of a copying function of a certain quality. The machines are placed at a customer's site but are retrieved when the contract period ends. They can then be re-conditioned, have parts exchanged or be used as parts in other machines. It has turned out to be a profitable concept, and it is believed to be environmentally preferable. There is no known LCA regarding this practise, but the company states it was started as a cost saving effort and that it has been very successful in this regard.

Other products would lend themselves to similar business ideas. Many manufacturing companies, including the manufacturers of cars, white goods and electrical equipment, offer leasing, but only in a limited way and without any advanced reuse of the equipment. For sales to private persons and manufacturers of other types of products, the selling function concept poses a major challenge, but could also provide great opportunities for increasing the value of their offer while reducing the environmental impact.

Selling functions in literature

This chapter is a summary of the literature studies. It presents findings related to; the concept, the market and the environmental driving forces, the benefits for the environment, the customer and the supplier.

Selling functions - the concept
Selling functions instead of the physical product in order to improve the corporations' environmental performance is a relatively new concept within environmental management literature (Sprotte, 1997, Rocchi, 1997). But as Mattsson (1997) suggests, what is considered new in the management literature, almost always has its historical roots, both in academia and practice.

The idea of focusing on the function instead of a physical product is not in itself a new concept. Already in the 1960's, marketing scholar Levitt (1960, 1972) suggested that it is of greatest importance for managers to understand the product's core benefit, i.e. the fundamental service or benefit that the customer really is buying, if they want to succeed with their business. Levitt claimed that many companies had a too narrow definition of what they actually offered and that they were focusing too much on the generic product instead of the benefit the product provides.

Levitt's ideas can be described as a corporate philosophy based on the idea of identifying the needs of the customer and organising the activities of the company to satisfy these needs, rather than to satisfy the needs of the company. Selling functions is in line with these ideas, since the concept is based on the assumption that the central customer value of a product lies in the use and the benefit that it provides rather than in the ownership. The customer pays only for the utilisation of the product, not for the product itself.

The idea of selling a function could also be seen as a product concept of the service economy, in which the service element of the total offering is increasing in importance (Grönroos, 1993, Stahel, 1996). In order to meet customer needs and to be more customer oriented several manufacturing companies provide new value-added services to their core products (Grönroos, Ibid). The concept may also provide the manufacturer with an opportunity to turn possible future take-back obligations into competitive advantages (Hart, 1997).

The concept of selling functions and not products is however a more far-reaching development than just providing value-added services to a traditional core product, since the focus on the core benefit of the product can lead us to challenge the concept of ownership. As Sprotte (1997) suggests when analysing the corporate rationale for selling functions instead of products: "*In most cases, people buy products not for ownership itself, but for the benefit or utility the product provides*".

Since selling functions is a concept that holds the potential of improving a company's competitive position as well as its environmental performance, it has attracted attention from several management scholars. The selling function concept has been identified to be a key to customer orientation and environmental adaptation for

manufacturing companies (Abrahamsson & Eriksson, 1997, Sprotte 1997, Rocchi, 1997). Accordingly, selling functions has the potential of making up the basis for the development of so-called win-win-win business strategies (Elkington, 1994), which are aiming at benefiting three parties: the customer, the company and the environment.

Market driving forces

Competition among industries has been increased by:

- development and standardisation of technology
- shorter product life cycles
- entry of new players on the marketplace as a result of deregulation and globalisation
- slower growth within the manufacturing sector during the 1980's and 1990's

These changes have led to a shift in negotiation power from the manufacturer to the customer (Grönroos, 1993, Sprotte, 1997). Consequently, customers can be more particular in their choice of supplier, and also have a greater array of suppliers to choose from than before. Developing, producing and distributing products of high quality at a low cost and at the right time, has become a necessity for the manufacturers (Lindbergh et al, 1993).

At the same time, technological development and standardisation has made it more difficult to differentiate products. Many manufacturing companies are experiencing that their physical products are beginning to resemble homogeneous commodities rather than heterogeneous products. In such a 'commodity market', price competition is fierce, and the supplier that offers the lowest price gets to sell, which eventually will result in low profit margins within the whole industry.

According to several management scholars (Porter 1996, Kim & Mauborgne 1997), management in many companies has too often dealt with the increased competition by focusing too much on operational effectiveness. They suggest the focus should rather be on developing and reinforcing their own distinctive competencies in order to be able to deliver an unique mix of value to the target customers. If they do, many manufacturing companies will be forced to abandon their traditional production orientation - focusing on internal efficiency and the view that a good product will sell itself - and instead try to organise their business to meet and satisfy the customers' present and potential needs.

In order to combat the market tendency towards commoditisation and low margins, many companies have tried to find ways to differentiate their product offerings and deliver something unique to the customer.

Environmental driving forces

During the last decades a shift of focus can be noticed within environmental management. In the 1970's and 1980's, legislators and other environmental stakeholders, such as environmental organisations, were mostly concerned with pollution stemming from production processes. This was reflected in the environmental legislation focusing on point-source pollution. In order to comply with legislation corporate environmental management focused on "end-of-pipe" technologies for pollution control. Since then, point-source pollution has been reduced

significantly, particularly in the OECD countries. With increased awareness of global environmental problems, such as green house gases leading to climate change, focus has now turned from production processes to the products and our life styles (Plogner, 1996, Andersson & Wolff, 1996).

There are several driving forces behind the development of selling functions and similar service augmented product concepts among manufacturing companies:

- Increasing environmental knowledge and awareness of the general public and of politicians has resulted in global environmental treaties, such as those of Rio 1992 and Kyoto 1997. Another result is the increased number of environmental stakeholders. Some of which question the ecological sustainability of current industrial and organisational practices and demand that they improve the environmental performance of their products, services and processes (IVA & McKinsey 1995, Meima 1997, Larsson et al, 1996).

- Society's increased concern is reflected in the introduction of "market-based instruments" of control, such as extended producer's responsibility and government sponsored programs for eco labelling. Extended producer responsibility is an organisational approach to promote the development of products that cause less environmental impact when they are no longer. Manufacturers will increasingly become responsible for the take-back and disposing of the used products (Kretsloppsdelegationen, 1996).

- Standards for environmental management (ISO 14001 and EMAS) and environmental life cycle assessments (ISO 14040) have been developed. Many large companies now adhere to the environmental standards and require the same from their suppliers (Tibor et al, 1996).

- Companies adopt systematic approaches for integrating environmental issues into product design and development process. Such methods include Life cycle assessment (LCA), Design for environment (DFE), Life cycle design (LCD) Green concurrent engineering etc. The basic idea behind DFE and related methods is to increase the product quality and profitability by attacking the lack of environmental quality and reduce the product's life cycle cost (Karlsson, 1997).

- The terms Factor 4 and Factor 10 have been put forward to illustrate how much the resource efficiency needs to improve in most OECD countries (Gee & Moll, 1998). Factor 4 is sometimes expressed as "doubling wealth and halving resource use". It addresses the eco-efficiency ratio (welfare per use of materials, energy and pollution). No explicit time target is given (von Weizsäcker, Lovins and Lovins, 1997). Factor 10 addresses the absolute amount of materials, energy and pollution per unit of welfare. The assumptions of Factor 10 is that the use of or access to natural resources should be halved and distributed equally all over the world. This leads to an absolute reduction in the use of materials, energy and pollution by a factor 10 for the OECD countries, since 5 times more people live in none OECD countries. The target periods is "within one generation" which is usually taken as 25 years (The Factor 10 Club, 1997).

Environmental benefits
The overall aim of LCA, DFE and similar approaches is to reduce the product's material consumption and energy use during its life cycle, as well as the energy consumption of the material production, while performing the same function. The material intensity can be decreased by better material management and by waste prevention. Product and components are designed so that they can be easily recycled, reused, replaced or recovered in their highest value-added application. Also a product's energy efficiency can be improved by technological development, such as smart material selection and design solutions (Karlsson 1997, Simon & Sweatman 1997).

DFE and related concepts provide a set of tools that help the designers and engineers to integrate environmental concern into the product development process and thus improve environmental performance. Yet, it should be stated that these concepts are just tools in the design process and do not provide the company with an approach to deal with extended producer responsibility. In order to do so in the most effective and efficient way, both economically and environmentally, many companies might have to redefine their operations and product offerings.

Stahel (1996), suggests that a selling functions approach can give the manufacturing company a competitive edge and future strategic position. Stahel's analysis is based on an environmental perspective and the concept of eco-efficient service economy. The eco-efficient economy is based on a management philosophy which aims at reducing waste, pollution and consumption of resources, while at the same time adding more value in goods and services.

As a result of selling the function of a product, the producer retains a larger responsibility, which creates incentives for the manufacturer to develop more economically and environmentally apt products. Uninterrupted ownership of the product offers the manufacturer the opportunity of closing material flows by reusing, recycling and re-manufacturing products and components. Selling functions is thus believed to be an organisational approach that corresponds to the increasing environmental demands.

Customer benefits
Customers might not be aware of the potential economic and environmental benefits of buying functions. When the supplier takes on a greater responsibility for the products and the result of their utilisation, a number of benefits can be gained: increased flexibility, reduced financial risk taking, easier access to new technology, a clearer cost structure and operations analysis. Suppliers can offer the customer tailor made solutions consisting of a mix of core products and services, including financing, ongoing monitoring of results, training of the operators, guaranteed performance levels, potential for upgrading or reconfiguring into new system with higher resource efficiency (Abrahamsson & Eriksson, 1997).

In addition it facilitates take-back and reuse schemes which can reduce life cycle cost and improve both the supplier and the customer's environmental performance. The

performance guarantees that the supplier gives the customer a sense of "peace in mind" and thus more time to focus on core activities (Gunnarsson, 1998).

Supplier benefits

Nowadays, it is a trend that companies, in order to become more competitive, outsource more peripheral activities that a supplier can produce at a lower cost or at a higher quality than if produced 'in-house' (Slack et al., 1998). This outsourcing trend opens business opportunities for companies that have developed the selling of functions concept. By guaranteeing the operation of a function or a set of activities constituting a function, the supplier can win new orders. In fact, it is not necessary for the function supplier to have all the necessary activities in-house, but it must be able to deliver additional customer value by providing the function in question.

The rationale for the supplier's deeper involvement in the customer operations is that it gives the company better understanding of the customer needs and conditions, which in turn improves the supplier's ability to adapt its offering to changing customer needs and requirements (Mattsson, 1995). It also opens up boundaries between company and customer and facilitates the gathering of market information on which management can react on in real time. By building close, long-term relationships with customer the company can decrease the defection rate among its customer and also increase sales (Buttle, 1996).

To build, maintain and develop exchange relationship to customers is particularly strategically important in the industrial market and in mature markets in which it is difficult to attract new customers (Buttle, 1996, Mattsson, 1995). Winning new customers is significantly more costly than retaining existing customers. Buttle (1996) emphasises this and suggests that when customers defect, they take with them all future income streams. The selling function approach implies a closer relationship between the supplier and the customer. This could be of mutual interest since it can facilitate value creation for both parties (Abrahamsson & Eriksson, 1997).

Case 1 – Selling painting of a car instead of selling a paint box

Background

The object of this case study is an Interior Base Coat (IBC) cell in which the interior of the car bodies is painted by robots. The case study is a theoretical discussion, as no real test has been made of selling functions instead of products.

Volvo Car Corporation bought the studied equipment from ABB Flexible Automation. The sale involved a number of ABB companies, where each one was responsible for a different part or service. ABB Flexible Automation held responsibility for the total performance of the delivered system. The sale included installation at the plant and start-up. After the star up Volvo assumed full responsibility for running the equipment. In problem solving Volvo contacts the concerned ABB parties, who also supply spare parts when necessary.

Volvo is the expert on painting vehicles, while ABB Flexible Automation has the expertise on the painting equipment. Knowledge was transferred to Volvo on how to run and optimise the painting systems performance at the time of the start-up. New improvements in technology by ABB Flexible Automation have, however, to be "sold" to Volvo as new investments. In the purchase situation it was important for Volvo to get the best performance at the given price and time.

Further developments in the system require new investments by Volvo, rising the need for gathering of information, decision making and implementation. Often it takes one to two years to make an investment, during which time a technology change could have given considerable gains in terms of cost reduction and quality improvement. If ABB owned the equipment and were selling the function of painting car bodies, ABB could implement new technology faster, and both parties could reduce their costs.

Based on the above it could be assumed that there could be considerable profits for both ABB and Volvo if ABB Flexible Automation sold the function painting instead of the equipment to Volvo Car Corporation. The advantages and disadvantages of this approach will be discussed below in terms of environment, business and company goals.

A summary of the potential advantages of selling functions:

- Integration of a supplier in the development process shortens lead times
- Faster implementation of new technology
- Both companies gain from performing at their best for the full lifetime of the agreement
- Less work spent on optimising purchases leaves more room for development
- Equipment has another life after being replaced

Paint cell specifics

Four robots do the IBC painting of car bodies, four are door openers and two are hood and lid openers, see figure 2. The car bodies are transported on rails through a paint box consisting of a steel frame with aluminium sheets. It takes 100 seconds for each

car body to pass through the painting operation. Ventilation is necessary to remove paint drops from the air to keep a high surface quality. Air is also needed for transporting the paint from the paint gun to the object. Pumps, colour changers, valves and regulators are placed on the robots. 170 000 car bodies are assumed to be produced each year, and the economical lifetime of the robot unit is set to 7 years. The technical lifetime of the units without major changes is for Volvo about 10 years.

Figure 2 Schematic picture of the inside of the paint cell

Environmental aspects
A simplified life cycle assessment of the paint cell was performed using the LCA tool EcoLab with ABB's database. The aim was to see where the largest environmental gains could be made.

The functional unit was selected to:

interior base coating per car body during the economical lifetime of the equipment.

This means that manufacturing; use and disposal are calculated for this unit.

The following simplifications and assumptions have been made:
- material amounts for robots and paint box were estimated and included
- the used materials data comprise extraction of natural resources to supplied material
- no processes for manufacturing of robots or paint box were included
- air handling energy required in the painting process has been included
- materials and manufacturing of the ventilation equipment were not included
- no processes, besides painting and related air handling, were included
- in the use phase 275 MJ/body of Swedish electricity mix was used (mainly ventilation)
- the energy mix data comprise extraction of fuels to produced electricity
- it was assumed that all solvents contained in the paint were emitted to air
- it was for simplicity assumed that no materials are recycled
- no solid waste from the painting process was included
- environmental impact of disposal on landfill was considered to be small compared

to other inputs and was not included
- transports were not included

The substances used in painting can be divided into materials for the robots, equipment paint box and consumables (pumps etc) according to table 1.

Table 1. Input data for LCA presented in totals and calculated on 1,19 million car bodies

Substances	Robots kg/cell	Robots g/body	Paint box kg/cell	Paint box g/body	Consumables g/body	Paint g/body
Steel	10500	8,84	25000	21	0,106	
Aluminium	612	0,514	1650	1.3		
Copper	98	0,082				
Plastics	84	0,071			8,9	
Oil	16	0,013				
Paint						1830

The different assessment methods available in the LCA tool were used. All basically indicate the same result. It is the use of energy and consumption of paint in the painting process which give the majority of the environmental impact, see figure 3. This is also substantiated by a comparison of classification data, see figure 4.

Figure 3 Environmental impact from interior base coating per car body evaluated by ten different evaluation methods (normalised to be possible to compare in the same graph).

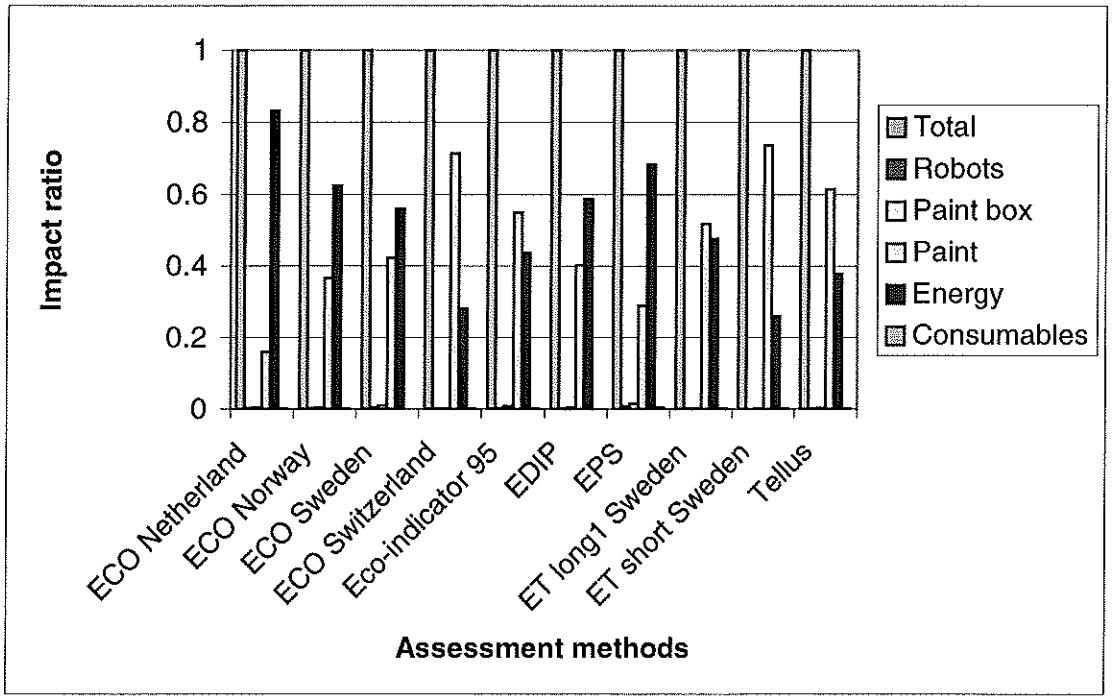
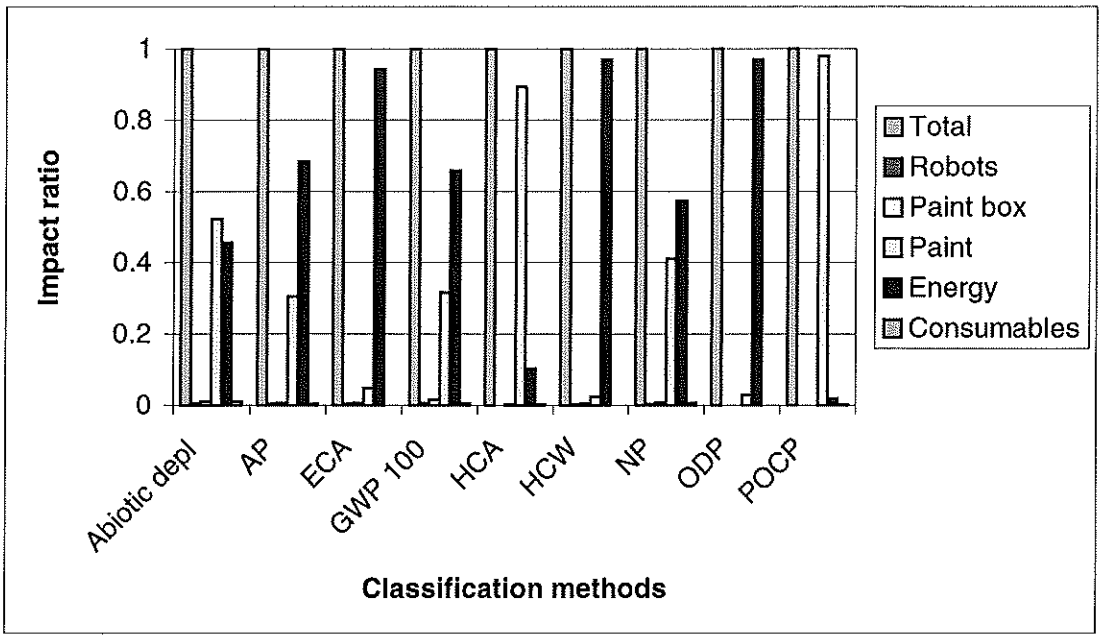


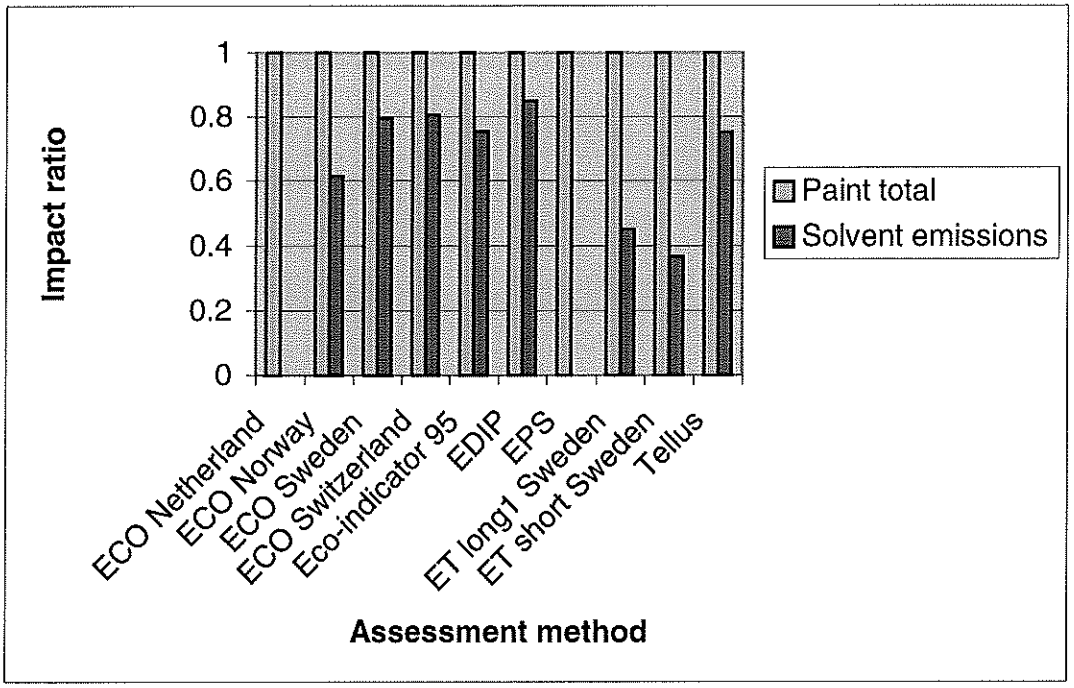
Figure 4 Environmental impact in categories (normalised to be possible to compare in the same graph: AP-acidification, ECA-aquatic eco-toxicity, GWP-global warming, HCA-human toxicity from air pollutants, HCW-human toxicity from water pollutants, NP-nitrification, ODP-ozone depletion, POCP-photochemical ozone).



The major impacts from the paint come from emissions of solvents and manufacturing of the pigment titanium dioxide. Figure 5 shows the impact of solvent emissions compared to the total impact per litre of used paint. The rough assumption that all of the solvents are emitted to air mainly increases the effects of human toxicity from air and photochemical ozone creation. At Volvo only some of the emissions are truly emitted to air but to get the picture of the real emissions would involve including a number of cleaning facilities into the studied system. This was not felt to be warranted in a simplified study like this.

The assumption of no recycling of materials was legitimated by the fact that in most evaluation methods only less than 5 percent of the environmental impact came from use of materials. This also indicates that the omission of materials for ventilation equipment made no real difference.

Figure 5 Environmental impact of solvent emissions compared to the total impact of paint (per litre) using ten different evaluation methods (normalised to be possible to compare in the same graph).



Economical aspects

The cost for the sold IBC equipment was 6.3 million DM. Per car body this is 24 SEK. The cost for paint varies between 185 and 550 SEK/kg. For this study a cost of 320 SEK/kg is assumed, which results in a cost of 610 SEK per car body. Consumables are approximated to 10 SEK per body. Cost for energy is approximated to 30 SEK, considering energy use for ventilation, transports and waste treatment. If an unplanned stop in production occurs due to a failure in the equipment it costs approximately 250 000 SEK/h. No such stops have been included in table y, which shows a summary of the costs.

Table 2 Cost for equipment, consumables and energy.

	Cost per car body in SEK
Equipment	24
Consumables	10
Energy	30
Paint	610
Total	674

It is obvious that the largest cost comes from the paint consumption. Only 60% of the used paint is applied to the car body. The rest is lost. Technological improvements saving paint would therefore be valuable both in environmental and economical terms. Improvements related to decreasing the loss of paint could also lead to lower energy use by less demand for ventilation and waste treatment.

From the above, just considering the paint loss, a technology improvement reducing the paint loss from 40% to 30% (= 61 SEK/car body) would represent a saving of 10.4 million SEK per year. If the process from decision to implementation for new technology could be speeded up, large gains could be made.

Product development
New technology for painting is continuously developed by ABB Flexible Automation. A technology that is on the verge of being released is the Robobell method. Paint robots can be supplied with a painting bell instead of a gun, which gives more efficient painting i.e. less paint is used. Painting bells have been on the market for a while, but so far only in fixed settings. Other technological developments are in the pipeline to improve painting efficiency. If ABB was selling the service of painting, such improvements could be introduced more continuously and at an earlier stage, giving larger savings in materials and processing costs.

Volvo meeting ABB
With the above knowledge in mind a meeting was set up to discuss if and how a hypothetical selling functions deal between Volvo and ABB Flexible Automation in the particular case of painting car bodies could be implemented. The discussion could be divided into the following topics:

Development
Much of the development in painting of car bodies is related to changes in the design. Changes in shapes and materials result in new demands on both the paint and paint processes. Trends that are seen today are lighter designs requiring paints applicable to aluminium and different plastics.

There are also demands for new colours and better corrosion protection. At the same time a large effort has been spent on reducing lead times in order to cut costs. To reduce lead times Volvo has entered a partnership with their paint manufacturer. The paint manufacturer is involved in the development process at Volvo, which speeds up realisation of new ideas within Volvo.

A similar partnership with the paint processing equipment manufacturer, in this case ABB Flexible Automation, could be a natural next step. A three-way partnership might also lessen the need for drawing up strict lines for responsibility. Risks would be shared as well as profits. This could also be one step towards possibly implementing the concept of Volvo not buying the equipment but buying the painting service from ABB.

Purchasing
The concept of selling functions saves time used for negotiations, since contracts can be signed for longer periods of time. Longer contracts also mean that suppliers would be changed less frequently. This might be seen as rendering difficulties in competition in the market place. Possibly competitors would not find it worthwhile to offer their products to Volvo, if ABB was considered to be the preferred supplier. These effects, however, already exist due to Volvo's present supplier partnerships. Selling functions instead of products would not really increase these difficulties to any greater extent.

One important aspect of partnerships was the motivation for suppliers to continue performing well even if they got to sell less of their product. The partnership with the paint supplier was given as an example. The Paint Company gets part of the profit made on more efficient painting for each car body. This means that they still profit, even if less paint is used. It was felt that new ways of looking at profit were necessary. The profit sharing principle, however, requires a much larger openness concerning prices and costs on both sides. If ABB joined the partnership that Volvo has with the paint supplier the profit would have to be shared by all parties. The question of who pays the development costs would come into focus.

A closer co-operation between Volvo and ABB would mean sharing the responsibility for high performance of the painting unit. This would speed up problem solving. Also, a constant presence of ABB people at the site would increase ABB's competence in painting, which is the case for the paint supplier Volvo already has a working partnership with. Both these things would decrease the lead times.

Operation

The three most important factors in painting of car bodies were considered to be:

- Availability
- Quality
- Paint consumption

Volvo has a very high competence in painting, which they feel has to remain within Volvo, as painting is one of their core activities. Some of the obstacles to the principle of selling the painting service therefore are:

- ABB Flexible Automation is at present not ready to take over the painting. Flexible Automation has little experience of running a paint shop and guaranteeing consistently high quality.
- Quality of the painting of car bodies is highly prioritised within Volvo, due to very high customer demands. As the painting also is a very sensitive process, Volvo wants to keep control over it. Ownership of the equipment is not as sensitive an issue as the ownership of the process. Repainting of a faulty car body doubles the paint consumption and causes delays.
- Painting is an integrated part of the car manufacturing. The flow of cars through the factory is important and the painting section is a bottleneck.

Conclusions from the case study

It is clear that major benefits stand to be gained from the concept of selling functions for both parts in economical and environmental terms. Paint consumption, energy use and lead times could be reduced. However, painting is a core process over which Volvo feel they can not afford to lose control. ABB on the other hand is presently not qualified to run the paint shop. It was commonly agreed that a closer co-operation in a partnership was more desirable at present. A working partnership could bridge over some of the gaps and the concept of selling functions could become more interesting in the future. It was clear from this study that it might be easier to sell the concept for a process which is not a core process for the buyer.

Case 2 – Selling a cleaning function instead of a cleaning machine

Background

In the spring of 1995, the management team of the professional cleaning equipment[1] division, Electrolux Euroclean[2], was offered to try a new approach for identifying and assessing environmental opportunities and threats. The assessment considers both short term and long term issues. The approach was developed by Electrolux Environmental Affairs and called the Environmental Change Program.

The first step of the program was to undertake a strategic investigation of the business environment with a special focus on environmental issues and demands. The customers in the cleaning service industry are of two main types. In-house cleaners, that are employees of the organisation where they clean and Contract Cleaners that are professional cleaners. Particularly the latter operate under intense competition and eroding margins. One trend is for the large Contract Cleaning companies to acquire competitors to reach economies of scale. This also affects their suppliers of equipment and machines and makes their industry highly competitive and price focused.

In some countries, primarily in Northern Europe, environmental communication is attracting interest among the customers and their customers. Historically the focus has been on the types, amounts and number of cleaning chemicals used. The interest is growing since many companies use environmental messages as a way to differentiate themselves and to support an image of being more dependable and having more of a long-term focus.

The second step of the program was to look at the impact on the business strategy based on the current situation and possible future conditions illustrated by scenarios. The process and the results were used as a way of challenging the managers' thinking. The objective was to integrate the concern and awareness of the environmental issues with the business strategy and to set up action plans. The scenarios were used as eye openers. The program started with the global managers and was then rolled out to other more local management teams.

Three scenarios were developed and used to initiate discussions what the future could be like. One[3] focused material use, reuse, recycling, the emerging regulatory changes regarding waste management and the discussions of introducing an extended producer responsibility making the manufacturer responsible for the management and cost of disposal of used products.

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[1] *The machines sold are; Vacuum cleaners, Wet & Dry Vacuum Cleaners, Carpet Extractors, Burnishers, Polishers, Scrubber Dryers, and Sweepers.*

[2] *This company is since October 1, 1998, part of the Nilfisk corporation of Denmark.*

[3] *The scenario was inspired by the experience of another Electrolux company that work with the manufacturing and rental of tarpaulins and more advanced protective products for the construction industry. The resulting ideas were also inspired by the successful scheme developed by Xerox of renting copiers with full service, guaranteed function and charging for it based on the number of copies made, instead of only selling a copier machine.*

There were several results from the use of the scenarios. One was that Euroclean became more aware that there were ways that the current product offer could be more comprehensive and thus improve its value to the user and meanwhile reduce the user's total environmental impact and the total cost of using the product. The reduced impact could be achieved in three ways. These are reduction of the consumption of electricity, chemicals and spare parts, a longer product life and reuse or recycling of parts and materials. In addition, it was clear that its products could have an economic value to the manufacturer even beyond the economic use for the customers, since a supplier could reuse the material or parts of the product. The idea was then to explore the opportunity to sell the customer a function and not a product.

A working group was set up to create a model for what was first referred to as the Loop (indicating a focus on the take back and reuse of old machines). Later the name changed to Functional Sales as it became clear that the major challenge short term was to create an attractive and competitive offer to selected customers. Still later the salesmen called it Functional Hire or Purchase to describe the concept from a customer perspective. One product name used for the offer is REFORM, see figure 6. Note how the concept can be used to address several customer concerns and not only improve the environmental performance.

Figure 6 Presentation of REFORM

We offer trouble free access to machines and sundries:

- A survey to define your cleaning need
- A method that matches the need
- Input for calculating labour and other costs
- Supplies of the best chemicals and accessories for the method
- Rental of the right machines
- Unlimited training of your staff
- Guaranteed non stop machine performance, including all maintenance and repair
- Guaranteed environmental performance, machines are recycled after they are used

All this is included in REFORM. An offer available at a fixed monthly fee, paid only as long as your need remains.

A majority of the initial work was to assess the cost of the additional services and the refurbishment. This was based on different assumptions regarding the lifetime of the machine, the service costs, the cost of refurbishment, the operator behaviour and the operating conditions.

The Swedish part of International Service Systems (ISS) became interested in the concept after an initial contact in 1995. ISS is the largest cleaning company in Sweden and one of the most international players in this business. Moreover, ISS has developed an environmental strategy and are increasing their environmental demands on their suppliers. The initial contact led to a discussion of conditions, prices and a test of all machines needed for doing the cleaning at a large supermarket in

Stockholm. Euroclean teamed up with a local company "Stockholms Truck och Städmaskinservice", STS, that were to handle maintenance and repair. This test was used as a case for this study.

It was assumed that there could be sufficient savings for both ISS and Euroclean if Euroclean provided the guaranteed function of the equipment to ISS. The test has since then been found successful and several more contracts have been signed

Cleaning machine specifics

In order to assess the environmental effects of the transfer to selling functions a commonly used larger type of cleaning machine was chosen. It was also used in the actual test. The machine is called Scrubber Dryer, see figure 7, and is equipped with a fresh water tank of 35 litres, brushes or scrubbing pads, a squeegee and water suction unit. The machine distributes fresh water mixed with a cleaning liquid under itself, scrubs the floor and sucks up the dirty water and stores it in a tank.

In order to make the machine operational, water, cleaning liquid and two batteries are needed. The batteries normally last half the calculated lifetime of the machine which is about 2,5 years. During the calculated lifetime, a number of other parts, e.g. the brushes, will be worn out and replaced during maintenance or repair. The substances used for manufacturing, maintenance and repair are found in table 3.

Figure 7. A 455 scrubber dryer

Table 3a Consumption data

Material consumed during the product's life cycle		
	Material content of the machine in kilograms	**Material content of Consumables and Spare parts in kilograms**
Ferrous metals	43,1	
Aluminium	13,7	
Plastics	19,5	58,2
Rubber	3,7	18,5
Electric motors[4]	19,5	5,5
Electric components[5]	2,5	
Unspecified [6]	5,9	
Subtotal	107,8	82,2
Batteries		
Lead		179,5
Acid		73,9
PP		10,6
Subtotal (battery only)		264

Table 3b Consumption data

Consumption per hour of operation		
		Material content of in kilograms
Electricity *kWh*	1.33	
Chemicals [7]		10% concentration, high water consumption
Sodium carbonate		0,6
Alcohol ethoxylate		1,2
Ethanol		0,9

Environmental aspects

A simplified life cycle assessment was performed for a scrubber dryer using the ABB LCA Design Tool. The aim was to identify where the largest environmental improvements could be made, and to assess if the concept of selling a function would increase or decrease the environmental impact over the machines life. The functional unit was selected to be an hour of operation. The calculations assumed a lifetime of the machine equivalent to the economical lifetime, set to 5 years or 4000 hours. This means that manufacturing, use and disposal are calculated for this unit.

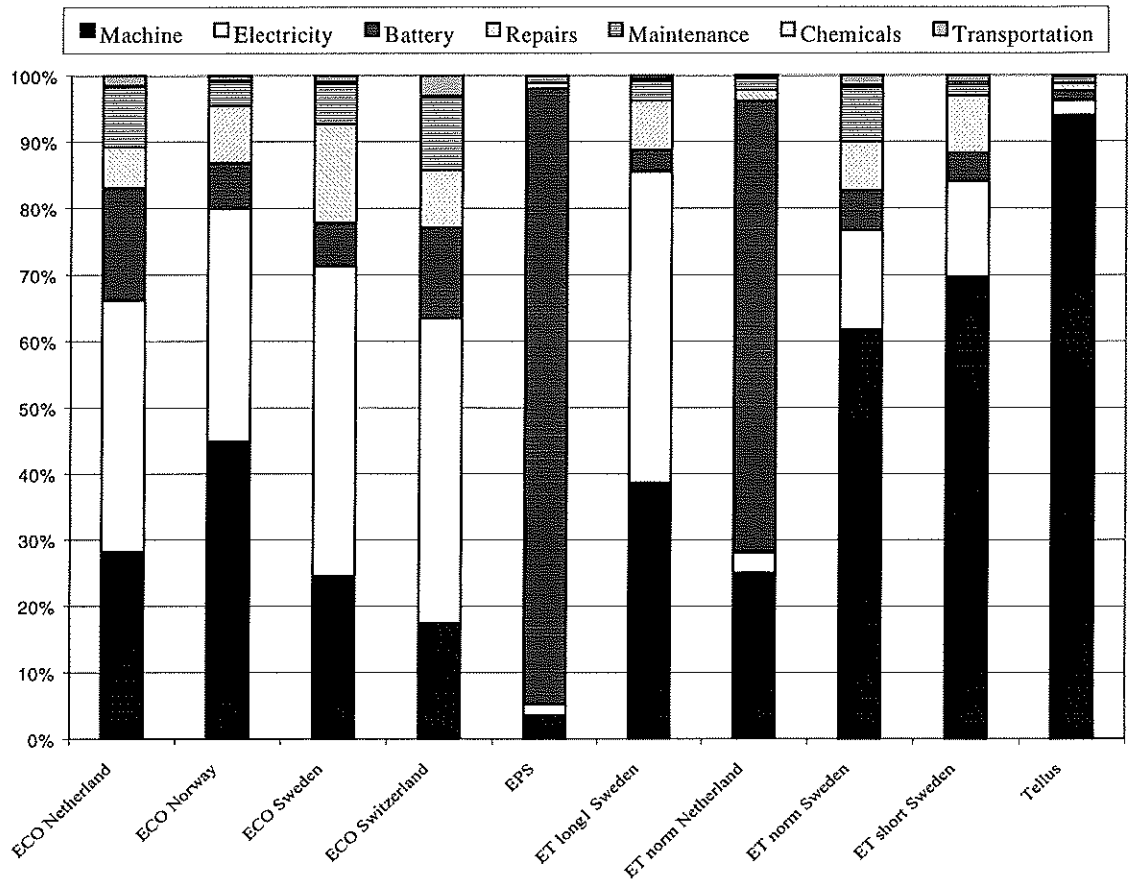
Simplifications and assumptions

All the ten different assessment methods available in the LCA tool were used, see figure 5. The following simplifications and assumptions have been made:

[4] The LCA uses averages regarding material content based on ABB estimates for motors
[5] The LCA uses averages regarding material content based on ABB estimates for electric components
[6] Assumed to follow the overall breakdown in materials
[7] Incomplete since there are only data regarding the environmental impact for a few of the ingredients. 10 % concentration is considered high and is assumed to be used together with maximum use of water

- a machine with the right capacity and dimensions is used
- suitable chemicals with low environmental impact and cost is used
- the machine is well maintained
- the operator has proper training.
- the amounts of material for manufacturing, maintenance and repair of the machine were estimated together with staff at the manufacturing unit
- the materials data comprise the extraction of the raw material
- no processes for manufacturing were included
- in the use phase Swedish electricity mix was used[8]
- the energy mix data comprise extraction of raw material to produced electricity
- the battery is assumed to last as long as technically possible, that is equivalent to a certain number of charges or 2.5 years according to the battery supplier (the life time depend on the maintenance of the battery and can vary with a factor 5)
- the only transportation considered is that of the machine from the factory in Italy to the place of use

Figure 8 Distribution according to source of environmental impact related to the life time of a cleaning machine; Scrubber Dryer. (Normalised to be possible to compare in the same graph).



- the travel of operators and service men are not considered as they are assumed to be reduced rather then increased by using the concept since better maintenance is expected to reduce the need for service calls and repair

[8] This electricity mix has a very low impact as no method considers the land use of the dams used to produced hydro power or the environmental effects of the waste from nuclear power

- the discarded machine, the battery and the replaced parts are recycled.
- containers for cleaning chemical are not considered, as they are of less importance

Results

There are four different sources that together cause more than 95 % of the environmental impact related to the machine. The sources are;

- the production and recycling of the material used to make the machine
- the production of the electricity used to charge the batteries
- the material used for the manufacturing and recycling of the lead batteries
- the material used for maintenance and repair

There are large differences between the sources' relative share of the total impact. This is a result of how the different methods consider the importance of the different environmental issues. Some consider political reduction target, others the society's willingness to pay and they do so in different combinations with scientific considerations. EPS, for instance, considers resource depletion important. It also emphasises global effects such as global warming caused by carbon dioxide. The relatively large use of the scarce metal, lead, and the energy demanding process of converting the ore to metal and the recycling of it explain why the impact related to the battery becomes so dominant in the EPS analysis.

It is, however, exaggerated compared to the actual practice as the only available data were for 30 % recycling, whereas the actual rate is 100 % recycling for this kind of batteries. For the same reason the energy data used are for the US energy mix and not for the Swedish energy mix that would have made the result more correct for the case as the test was made in Sweden. It would not, however, change the overall result regarding the battery much. However, if another energy mix based on the European average use of fossil fuels had been used the relative importance of the electricity use would have increased significantly.

All methods show that chemicals, contrary to many users expectations, have a relatively little environmental importance. The lack of data effects this analysis. However the analysis is based on an assumption of a very high consumption of chemicals and water per hour of operation and still the environmental impact is minuscule compared to the other sources analysed. One reason for this is that Electrolux Euroclean has developed the chemical used in this case with the specific aim of reducing the environmental impact. Since the concept of selling functions would reduce the amount of chemicals used the relative importance of chemicals can be expected to be very low.

Activities that can reduce or keep the environmental impact low

An analysis of the different sources results in a set of similar activities that can be used to bring their impact, see figure 6. The REFORM offer addresses several of the sources of environmental impact. It includes; a survey to define cleaning need, a method that matches the need using the right machines for the need, training of the operators, all maintenance and repair needed and a guarantee that the machines are recycled after they are used. The exact difference between today's typical impact and the impact is, however, hard to quantify since too little is known in detail about today's operations.

Figure 9 Summary of potential activities for reducing the impact

Source	Activity	Expected result
Machine	Improve; match, operation, New technology	Longer life
Electricity	Improve; match, operation, New technology	Less power used
Battery	Improve; match, operation, New technology	onger life, No lead
Maintenance/ Repair	Improve; match, operation, New technology	Longer life, Less power

The secured match between the specific need and the appropriate and guaranteed function that that the selling of a function bring, effects all the large sources. The cleaning capacity of the machine is used effectively keeping the number of operating hours, the electricity consumption, and the charging frequency low. The training helps to keep the consumption of electricity and chemical low. In addition the training is important to secure that the machine gets proper ongoing maintenance. All the more demanding maintenance and repair activities are executed by professional service men with a record over the past activities related to the specific machine and direct access to the supplier's knowledge and spare parts. This secures low consumption and enables reuse of parts. All these activities will also make it possible to prolong the lifetime of the machine.

The assumptions are important as they, in most cases, correspond to an ideal use of the machine, which is the result of the selling of a function. In a more typical case, without the benefits of the concept, the total impact is higher and even much higher. The cleaning need is determined primarily by the size and the lay out of the cleaning area, the flooring material, and the type and amount of dirt. If the machine does not match the need, the machine and the batteries would not last as long. The electricity consumption would be higher if the machine was not right for the need and not properly operated. If the regular maintenance were poorer need for replacements and spare parts would increase. Recycling of the material also increases the time the material is used, avoiding the use of virgin material

All the activities are made important by the introduction of the concept. The retained ownership and the guaranteed function, make it economically beneficial for the supplier to do things such as train the operators, maintain, and prolong the lifetime of the machine. But also to develop more robust machines that more easily can be repaired and upgraded.

Economical aspects

Generally there is little knowledge in both the supplier and the buyer organisations regarding the total cost of the function. Typically purchasers focus on the price of the machine without considering the expected running costs related to consumables, spare parts and, even more important, to labour costs, see table 4.

The list price of the scrubber dryer was approximately 50 000 SEK when the test was started and it is calculated to be used during 5 years.

Table 4 Estimate of the size of different types of direct costs for the function

	Cost per hour in SEK
Equipment	15
Consumables	10
Energy; electricity and batteries	5
Labour	140
Total	170

The customers can easily track the prices of machines and consumables but have a hard time quantifying the share of the labour costs that are related to the use and the handling of the machines. This is important since the largest cost associated with the function is the labour. Consumables, maintenance and repair are more costly than the machine as such.

If an unplanned stop in cleaning operation occurs due to a failure in the equipment, it not only jeopardises the quality of the cleaning, it also result in a lot of costs because of the manual cleaning necessary to complete the cleaning. The cost of poor quality and inefficiencies makes the reliability of the machine very important

Since the concept addresses the reliability and the match it has met strong interest from contract cleaners. Technical improvements that improve reliability and prolong the lifetime and thus make better use of the direct labour would be valuable both in environmental and economical terms. Improved training of the operators is important for keeping the chemical and battery consumption low. There is a difference in the life time of the batteries can be up to 5 times. The match between the machine used and the actual cleaning needs would also help save resources and time.

Product development
The concept strengthens the supplier's and the product developer's incentives to consider the users' needs and concerns.

A number of technological changes can be considered in order to reduce the environmental impact of the main sources. The main motor can replaced by another that last as long as the machines are used and reused. Today this motor assumed to be replaced once during the lifetime of the machine. It is also possible to use more energy efficient motors, if the higher cost this would bring could be accepted based on the lower battery costs or the environmental saving it would mean. The lead batteries as such are said to hard to replace with other forms of energy storage, but it is an important area to follow as the use of lead is likely to become more discussed and less acceptable by regulators and the general public.

The lifetime of the machine can also be prolonged by a more robust design, particularly of components such as hinges that frequently are put under stress. If the machine is designed in modules, it will be easier to reuse older part in new machines.

It is, however, unlikely that all customers would start to buy functions at the same

time and it would be very expensive to develop and manufacture machines solely for the sale of functions. Consequently the product developers must try to find ways to make the machines more environmentally and economically suitable to be used to sell functions, while also focusing on changes that are appreciated also by customers that buy machines and manage all aspects of them themselves.

Organisational implications
It was found that it takes 3 to 6 months for an individual to fully grasp the implications of going from traditional product sales to the concept of selling functions. Analogies from other industries and workshops dedicated to identify the opportunities and threats with going from selling products to functions, have proven useful for supporting the understanding.

It is important to make clear the responsibilities of the supplier and the user. The more routine maintenance and simple repair the user is willing to take on to do the less costs are created. Training is key for keeping the need for repairs and questions to a minimum. Manuals are also of great importance.

The relative complexity of the offer seem to make the concept an opportunity primarily for larger suppliers that are used to managing complex relationships and able to distribute the cost of establishing the necessary systems etc. to a larger number of functions. The number of functions is also related to the level of risk a supplier would be exposed to. The reason is that a large number of functions sold would increase the number of units that can carry the costs of software development etc.

The development of the concept involved solving a set of administrative challenges to the supplying organisations. How to do the accounting, what stock levels of machines are necessary to secure sold functions, and how will sales bonuses be determined? This is linked to the fact that it is primarily larger and/or more advanced customers that can be expected to want to let someone else manage the functions needed for their support processes. In addition they can be expected to have more advanced and larger fleets of machines and changing needs, making flexibility important.

Conclusions from the case study
To be able to offer functions has turned out to be a potential source of competitive advantage for Euroclean. Several qualified customers have also shown interest for the concept since it offers them flexibility, control of costs and an improved environmental performance and image.

There are four different sources that together cause more than 95 % of the environmental impact related to the machine. The sources are; the production and recycling of the material used to make the machine, the production of the electricity used to charge the batteries, the material used for the manufacturing and recycling of the lead batteries, and the material used for maintenance and repair. The secured match between the specific need and the appropriate and guaranteed function, that the sale of a function brings, reduce the impact from all these sources. Furthermore it creates a system where the supplier benefits directly from training the operators, maintaining the machines, prolonging the lifetime and to develop their machines in such ways that makes these activities easy and less costly.

The largest cost associated with the function is the labour. Consumables, maintenance and repair are more costly than the machine as such. If an unplanned stop in cleaning operation occurs due to a failure in the equipment, it not only jeopardises the quality of the cleaning, it also result in a lot of costs because of the manual cleaning necessary to complete the cleaning. The cost of poor quality and inefficiencies makes the reliability of the machine very important. Since the concept addresses the reliability and the match it has met strong interest from contract cleaners.

Finally there is a potential for further improvements of all aspects of the performance, not the least through product development. However, the largest challenge is not to make technical improvements but to create customer acceptance, as well as a sufficient organisational and administrative preparedness in the supplier organisation. Customer acceptance can only be built by proving the concept in practice. This requires creating an effective communication, a proper understanding of total costs and the environmental impact of the function performed by the cleaning machines and the consumables used.

Discussion

A number of general observations have been made while working with the case studies. In addition, a number of possible future research questions have been identified, see appendix 2.

How generally applicable are the conclusions from the case studies?
The cases are different and somewhat complementary. One difference is the size of the technical process. Another difference between the case studies was, that there were more parties involved in the paint box case study (several ABB companies, Volvo and paint suppliers) than in the cleaning machine case study (Electrolux Euroclean, ISS and the sub contractor STS).

In the case of Electrolux Euroclean the test of the concept was decided and the parties had agreed it was desirable provided it met the requirements. The Volvo/ABB case was chosen as it seemed promising from both an environmental and economic perspective, but the parties had not agreed that they actually wanted to test the concept operationally. The differences reflect the fact that the paint box function is related to a core process and not a supporting process.

The conclusions from the cleaning machine case study are most likely more generally applicable as they concerned a support process.

Introduction of the concept
The concept of selling functions can be introduced by taking a number of small steps that support the basic business. These steps include offering financing, training, systems design, service contracts, guaranteed back-up, take back service, second hand sales/ short term hire. The main difference between these steps and the full concept are that the customer will have little or no flexibility regarding how long the equipment is used and that the supplier do not retain ownership.

However, in the long term it will be hard to realise the potential of the concept unless it is the supplier's strategic goal to move in the direction of very close co-operation with its customers. By matching a market segmentation and an analysis of the needs of the selected segment with the strategic plans of the supplier, it would become clear if it is interesting to move towards this kind of increased customer co-operation.

One environmentally important challenge with introducing the concept of selling functions, is that customers understands the environmental gains of the offering and that they accept reused and refurbished machines and parts. This is easier for an environmentally concerned customer, than for a traditional customer to accept. It requires, however, that the customer can trust the supplier to only provide first rate products and services. This becomes easier to achieve when the supplier can guarantee the performance level of the functional sale products.

Critical success factors
A requirement for success is that the supplier is perceived as trustworthy and capable.

The supplier must also have the capacity for systematically collecting feed back regarding the customer need for the adaptation of the offer. It is also critically important for the supplier to have enough knowledge about customers total cost for the function.

However, it is also important that the customer is aware of the costs in order to appreciate the value of a supplier taking more responsibility. As a result selling functions makes it necessary to establish a long-term relationship for co-operation between the supplier and the buyer of the function. Thus, it is important to develop ways to share cost savings and the effects of improved quality and overall effectiveness.

Organisational challenges
The concept requires that the supplier organisation has a high degree of customer focus and this could have effects on how the supplier is organised. Since the concept challenges conventional wisdom in the sales and manufacturing functions within the company, the introduction needs to be gradual in order for all individuals and routines to adapt properly. The difference compared to the old approach may even warrant that each approach has its own dedicated sales force etc. since they aim at building quite different customer relationships.

An important area involves defining the different roles played by the companies which together make a functional offer possible. This includes the role of the sales company, the service unit, the finance company, the manufacturer and the recycling company.

Product development
The concept of selling functions is about optimising the system and not just the product. Suppliers and buyers of a function must work closer together in product development to make the functions work, particularly for system-based functions, such as a paint cell. Thus the development will have to be done in close co-operation with the supplier.

The concept opens up opportunities for product developers to afford solutions that may be more costly to produce, but that lowers running costs, as well as the impact from the use phase. It would also potentially increase the speed of introduction of new technology since the buyer would be more interested to try new solutions, as he would not have any capital tied up in a stock of machines, and thus not be concerned about depreciation and pay back requirements. The higher the speed of technology based productivity improvements, the easier it is to interest the user in upgrading the function technically.

Competing with customers
Selling to an actor further down the value chain may lead to situations where the supplier to some degree competes with its immediate customers. In order to handle such situations it is important to establish a coherent strategy for addressing different market segments. Second hand market is an alternative but it is typically unknown to the supplier organisation.

The role of information technology
As wireless communication and microprocessors become more affordable they are bound to become important tools for monitoring performance and to create feed back that can result in technical and other improvements.

Arguments against selling functions
Some arguments against the concept are; knowledge depletion, the non existence of trust, the cost of building trust, elimination of competitive dynamics among suppliers and increased travelling.

There is a risk that the concept leads to the depletion of knowledge in companies buying the function. This may make these companies more vulnerable. On the other hand this is already an increasingly important question, since increasing competition forces many companies to focus on their core processes.

The concept requires a strong sense of trust between the buyer and the supplier, regarding the capability and capacity to secure the performance of the function. In many relationships this is missing and may be too expensive to establish.

Competition can be reduced as the buyer chooses one special supplier to work closer with. Other suppliers might think it is not worth while trying to compete with them. From the buyer's point of view this can make the range of alternatives diminish.

The number of transports may increase, if the suppliers will need to go to their clients more frequently to maintain and repair their products. However, it is important to raise the questions; who does the service today and how well do the products operate on an average with this service?

Conclusions

Selling functions can have a number of environmental benefits. One potential benefit is that it facilitates and creates incentives for reuse of used products and parts to create new functions. Reuse would be easier because of the control the concept would give the supplier regarding maintenance and repair as well as the timing of when a machines is taken back. A more extensive reuse is also important for another reason. The concept is expected to shorten the period of use for each product and reuse will keep the returned products from becoming waste prematurely. The sale a function also provides the supplier with an opportunity to turn possible future take-back obligations into competitive advantages.

Selling functions instead of the physical product in order to improve the corporations' environmental performance is a relatively new concept within environmental literature. To focus on the function instead of a physical product is not, however, a new concept.

Two case studies have been performed to make it possible to evaluate the environmental and economic effects of selling functions. One case focused on the function of a paint box, sold by ABB to Volvo Car Corporation. This case study is a theoretical discussion, as no practical test of the concept was made. The other case dealt with the function of a cleaning machine actually provided by Electrolux Euroclean to the contract cleaning company ISS.

In the case of the paint box, major economic and environmental benefits could be gained from the concept for both ABB and Volvo. A technology improvement reducing the paint loss from 40% to 30% (= 61 SEK/car body) would represent a saving of 10.4 million SEK per year. If the process from decision to implementation for new technology could be speeded up, large gains could be made. Paint consumption, energy use and lead times for new technology could be reduced. Energy and paint consumption gives the largest contributions to the environmental impact according to the 10 weighting methods that were used. However, painting is a core process over which Volvo does not want to give up control. ABB on the other hand is presently not qualified to run the paint shop, as selling the function would require. Instead it was agreed that a closer co-operation in the form of a partnership was more desirable and the concept of selling functions may become interesting to test in the future.

In the Electrolux Euroclean case the concept proved to work in practice. It has met a strong interest from other qualified customers, for economic, quality and environmental reasons. It is, however, hard to quantify the expected environmental and economic savings since the current impact and costs are not known. In a typical case, without the benefits of the concept, the total impact can be expected to be higher and even much higher. There are four different sources that together cause more than 95 % of the environmental impact related to the machine. The sources are; the production and recycling of the material used to make the machine, the production of the electricity used to charge the batteries, the material used for the manufacturing and recycling of the lead batteries, and the material used for maintenance and repair. The secured match between the specific need and the appropriate and guaranteed function,

that the sale of a function brings, reduce the impact from all these sources.

In both cases the equipment represents only small portion of the total cost of the functions. The differences in how easy it was to get customer acceptance for the concept reflect the fact that the paint box function is related to a core process and not a supporting process. It is harder to introduce the concept for a process which is a core process.

Selling functions makes it necessary to establish a long-term relationship for co-operation between the supplier and the buyer. Thus it is important to develop ways to share cost savings and the effects of improved quality and overall effectiveness. Competition can, on the other hand, be reduced as the buyer chooses one special supplier to work closer with. Other suppliers might think it is not worth while trying to compete with them. From the buyer's point of view this can make the range of alternatives diminish.

The concept of selling functions has a great potential for reducing the functions environmental impact and increasing the value of what the supplier provides. Several challenges remain and there is a need for more environmental, economic and technical research. The largest challenges, however, seem to be to create a customer understanding of the value of a function and to transform the product focused mind set of the supplier's organisation to a more service and solutions focused way of thinking.

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Appendix 1 – A definition of Life Cycle Cost

There are many definitions of Life Cycle Cost. The following has been developed by Electrolux and is presented as an illustration.

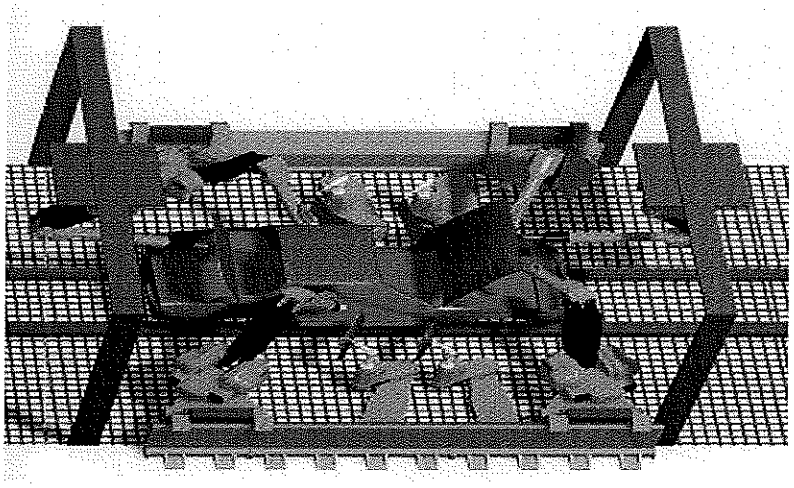
$$LCC = I + F \bullet \frac{1 - (1 + r - e)^{-r}}{r - e}$$

*F=E*c; (First year energy cost)*
E=Energy use per year (kWh/y)
c=Present cost for energy (Any currency/kWh)
r=Initial investment (Any currency)
I=Calculated interest (%/100)
e=Expected annual increase of energy cost (%/100)
T=Time for the evaluation (years)

Appendix 2 - Examples of possible future research questions

- How should the ecological impact of a selling functions be assessed and compared with traditional sales?
- Are there general conditions under which selling functions is ecologically preferable?
- What are the potential buyers'/users' attitudes towards buying functions and not owning the equipment used?
- What benefits and disadvantages do the buyers perceive?
- How can markets be segmented according to the buyers' attitudes?
- How can the buyers' concerns be addressed?
- What financial measurements are needed to manage and improve on the selling of a function?
- What organisational conditions foster on-going improvements of the function offered?
- What dictates the optimal structural solutions regarding logistics, location of reconditioning centres etc.?
- If the product development focus on minimising the Life Cycle Cost, what are the effects on the cost of the product and production?
- How should the ecologically and economically optimal time of use before refurbishment, upgrading, parts recovery, material recovery etc. be calculated?
- How can the business process within the company be changed to generate better asset management for both equipment and parts re-manufacturing?
- How to maximise the utility of unserviceable assets within and between the different groups by incorporation of a re-manufacturing component in the integrated supply chain?
- How to build upon the product delivery process to assimilate asset management and institute this throughout the company?
- What are the implications of asset recycling? Asset management means the process of reusing an asset (machine, subassembly, part, or packaging material) either by remanufacture it to its original state, converting to a different state, or dismantling to retrieve the original components
- How to maximise the return on assets by increasing the velocity with which non-revenue producing assets are transformed into revenue producing assets?
- What effects can selling functions have on the competitive dynamics among suppliers?

Fig 2



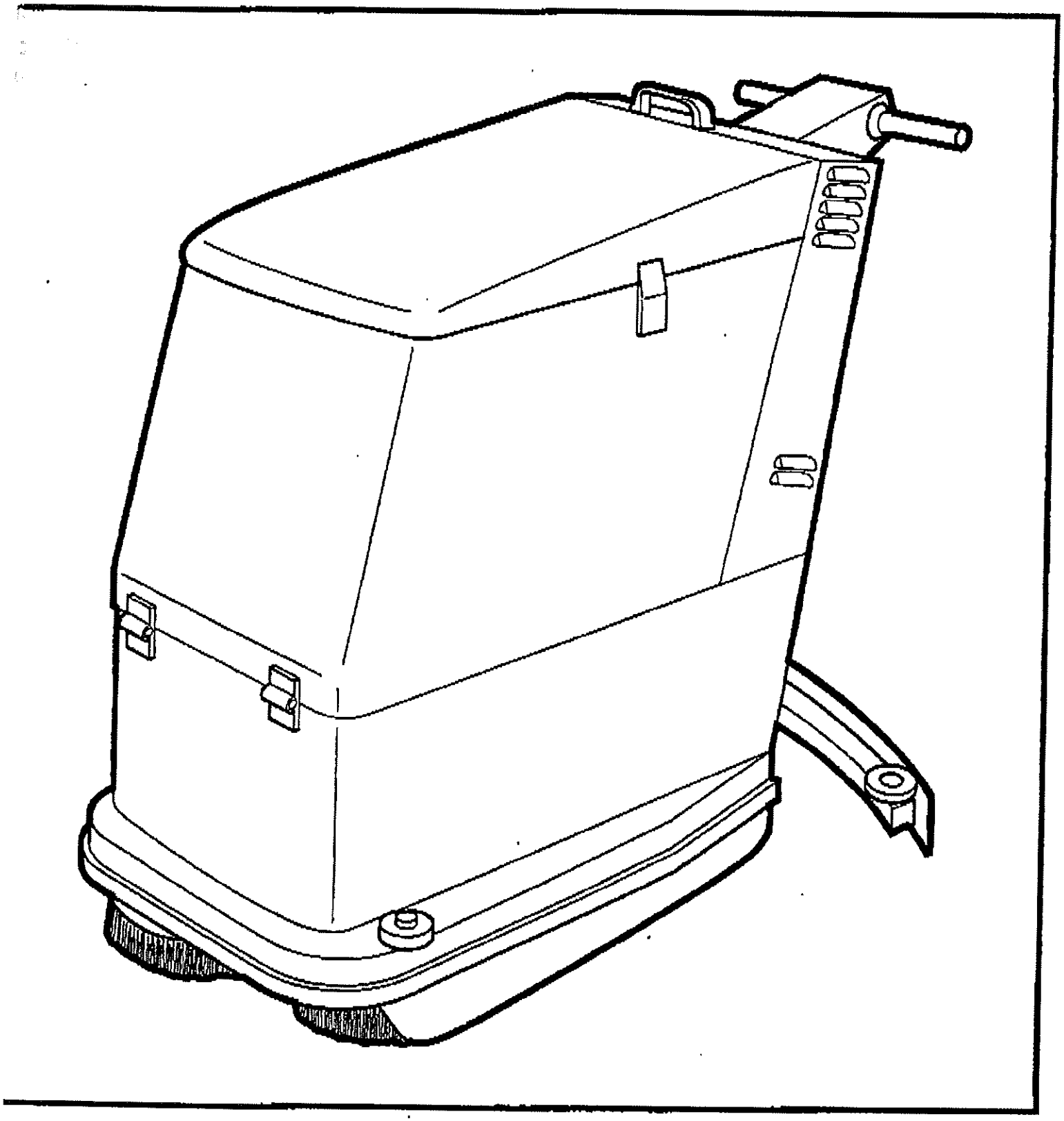


Fig 2